

The Impact of Workflow Management Systems on the Design of Hospital Information Systems

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Background. The services of a hospital depend strongly on the scope and the effectiveness of the *hospital information system* (HIS). It is the prerequisite for the logistics of hospital information. Due to many independent subsystems with overlapping workflows, the structure of (large) hospitals is complex and heterogeneous. Thus the management (including planning, building, and controlling) of HIS requires powerful and flexible techniques.

Conventional methods for the design of HIS (e.g., data modeling) have several disadvantages. A most promising approach is the application of *workflow management systems* (WfMS). They provide features for modeling, design, and implementation of (workflow-based) HIS.

Workflow-based HIS. Business processes describe the activities of an enterprise in a comprehensive manner. *Workflows* focus on the behavioral aspects of business processes with regard to a possible support of their execution through information technology. WfMS are software systems that support modeling and execution of workflows. The modeling facilities of WfMS focus on the answers to the following question: *What* is done (business processes and workflows) *how* (activities) *by whom* (participating actors) and *with what means* (tools). For execution the WfMS has to know the workflow specifications, the current state of workflows, the organizational structure, and the available technology. It uses the facilities of intra- and inter-organizational communication.

A WfMS-based architecture for HIS conceptually involves three levels: *Workflow management components* deal with the flow of work of one or more processes. *Invocation components* deal with the invocation of personal actors to perform manual or partly automated activities, and the activation of applications for automated activities. *Activity-based components* provide the implementation of one or more partly or fully automated activities.

Application. At the University Hospital of Saarland, some typical clinical workflows were analyzed. Wards and service units (e.g., departments of radiology, endoscopy, or pathology) have to cooperate and

to exchange information for the treatment of inpatients. This workflow is broken up into patient management (appointment and admission), performance of examination, and transfer of findings. A pilotproject is being carried out between wards and the department of radiology, equipped with a radiology information system (RIS).

The complete workflow is controlled by a WfMS (the workflow management component). The appointment is supported by printed worklists (generated by a worklist handler, i.e. an invocational component). For admission in the department of radiology the RIS is started for data entry (invokable application). The examination is again controlled by a worklist. For the recording of findings a word processor is started (activity-based component) with a suitable template. The RIS and the word processor communicate via OLE (Object Linking and Embedding). The findings are transferred to a communication server (Cloverleaf) using NFS (Network File system). An API (Application Programming Interface) is used for the transmission of findings to the clinical workstations of the wards.

Conclusions. WfMS permit the implementation of hospital processes in a distributed environment together with a reliable control of their execution. They allow the integration of existing application systems and the simultaneous consideration of manual and automated activities. Such a workflow-based HIS provides significant advantages: it enhances the degree of automatization in hospitals, it may be adapted to changes more easily than conventional HIS, and it provides facilities for integration of legacy systems in a heterogeneous application landscape.

Animation and subsequent analysis enable a better understanding of workflows, reveal weak points and deficiencies, and deliver suggestions for their optimization. Although existing WfMS have some deficits, we expect that the clinical requirements will lead to improvements of the systems. Our experiences up to now have shown that this concept improves clinical workflows and thus consequently leads to a better service for the inpatient.